REMARKS

Claims 1, 4-8, and 10-12 are pending in this application. By the Office Action, the title and specification are objected to; claims 1, 4-8, and 10-12 are rejected under 35 U.S.C. §112; and claims 1, 4-8, and 10-12 are rejected under 35 U.S.C. §103 and for obviousness-type double patenting. By this Amendment, the title and specification are amended, and claims 1 and 7 are amended.

Support for the amendment to claims 1 and 7 can be found in the specification as filed, such as at page 7, lines 27-29 and Fig. 1B. In particular, the duty ratio is a ratio of a width of grooves to that of ridges between the grooves. Thus, the amendment is supported at page 7, lines 27-29 and Fig. 1B. No new matter is added.

I. Objection to Specification

The title and specification are objected to for informalities. By this Amendment, the title and specification are amended to correct the informalities as helpfully suggested by the Examiner. Reconsideration and withdrawal of the objection are respectfully requested.

II. Rejection Under §112

Claims 1, 4-8, and 10-12 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite. The Office Action continues to assert that the meaning of the term "apodization exposure" is unclear, and states that it is understood that the term refers to an intended use of the claimed phase mask. Applicants respectfully traverse the rejection.

Applicants submit that "apodization exposure" is well known in the art, particularly with respect to phase masks and diffraction gratings. For example, attached are two references obtained from the internet (www.ericweisstein.com/research and www.wikipedia.org) describing apodization as it applies to phase masks and diffraction gratings. These references clearly show that apodization refers to smoothing discontinuities at the edges of the diffraction pattern or spectrum. This term, and its application, would thus

be well understood by one of ordinary skill in the art, and thus the present claims would not be considered indefinite.

Claim 1, for example, recites that the duty ratios for the grooves are selected so that the phase mask can be used to perform an apodization exposure of the object when the object is exposed to the UV light through the phase mask. Although the recited apodization exposure relates to a use of the claimed phase mask, clearly the term also limits the structure of the claimed invention. That is, the claim recites that the duty ratios for the grooves are specifically selected so that the phase mask can be used to perform an apodization exposure of the object. This limitation structurally defines the claimed phase masks over other phase masks, because if the duty ratios for the grooves are not appropriately selected, then the phase mask will be structurally different and cannot be used to perform an apodization exposure of the object.

Based on the description in the specification and the understanding in the art, the claims are not indefinite. Reconsideration and withdrawal of the rejection are respectfully requested.

III. Rejections Under §103

A. Claims 1, 4-8 and 10-12 Over Segawa and Inoue

Claims 1, 4-8, and 10-12 are rejected under 35 U.S.C. §103(a) over Segawa in view of Inoue. Applicants respectfully traverse the rejection.

Claim 1 is directed to a phase mask for forming a diffraction grating in an object for an optical medium by exposing the object to UV light containing diffracted light rays through the phase mask to cause a refractive index of a photosensitive part of the object to change by interference fringes produced by interference of diffracted light rays of different orders of diffraction, the phase mask comprising: a transparent substrate having a surface provided with a pattern of a plurality of grooves, the pattern being entirely transparent; wherein each of

the grooves has a duty ratio dependent on a position of the respective groove on the substrate; the duty ratios for the grooves are selected so that the phase mask can be used to perform an apodization exposure of the object when the object is exposed to the UV light through the phase mask; and the plurality of grooves are arranged on the substrate in a single pitch, the duty ratios being determined by varied widths of the grooves. Claim 1 also specifies that the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both peripheral portions of the substrate. Independent claim 7 is directed to a method of fabricating such a phase mask. Such a phase mask, and method of making a phase mask, would not have been obvious over the cited references.

The Office Action asserts that Segawa discloses all of the limitations of the claimed invention, except for a single constant pitch for the phase mask. The Office Action argues that Segawa teaches a phase mask including a substrate having grooves formed with a groove pitch varying between 0.85 and 1.25 μm. The Office Action further asserts that Segawa discloses varying a duty ratio of the grooves by varying widths and depths of the grooves according to their respective positions. The Office Action admits that Segawa does not teach that the plurality of grooves are arranged on the substrate in a single pitch, the duty ratios being determined by varied widths of the grooves. However, the Office Action argues that such a single constant pitch for the phase mask is taught by Inoue. Notwithstanding these assertions, Segawa and Inoue would not have rendered obvious the phase mask and method of claims 1 and 7.

1. <u>The References Do Not Teach or Suggest a Single Pitch</u>

In each of claims 1 and 7, a phase mask includes grooves arranged on a substrate in a <u>single pitch</u>, or a phase mask is prepared by forming grooves on a substrate in a <u>single pitch</u>. In claims 1 and 7, the <u>widths</u> of grooves vary depending on the position of the grooves. In Segawa, by contrast, a <u>groove pitch</u> is varied depending on the position of the grooves. *See*

column 3, lines 1 to 5. Even if Segawa may teach altering the groove widths, as argued in the Office Action, Segawa and Inoue nowhere teach or suggest that the grooves should be provided on the substrate in a single pitch, as claimed. This limitation has not been properly addressed by the Office Action, and is not described in the cited references.

2. <u>The References Do Not Teach or Suggest the Claimed Duty Ratio</u>

According to claims 1 and 7, the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both peripheral portions of the substrate. This limitation is also nowhere taught or suggested by the cited references. Segawa only teaches that the pitch is varied. However, variation in the pitch does not necessarily mean that the duty ratio is varied, and particularly does not mean that the duty ratio is set such that it is highest in the center of the substrate and decreases proportionally toward both peripheral portions of the substrate, as claimed. In fact, the pitch of the phase mask is independent of the change in the duty ratio, and any teachings relating to the pitch are not related to the duty ratio.

Inoue also does not teach or suggest this limitation.

Further, this limitation would not have been obvious over the cited references, at least based on the significant advantages that it provides. In particular, having the duty ratio as claimed, the optical intensity of zero-order light around the center portion can be reduced, and therefore the diffracted light beam from the phase mask can have a well-balanced shape. These benefits are nowhere taught or suggested by the cited references, and thus one of ordinary skill in the art would not have been motivated to modify the cited references to practice the claimed invention.

Accordingly, because neither Segawa nor Inoue teach or suggest that the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both

peripheral portions of the substrate, the references cannot have rendered obvious the claimed invention.

3. Conclusion

For at least these reasons, claims 1 and 7 would not have been rendered obvious by Segawa in view of Inoue. Claims 4-6, 8 and 10-12 depend variously from claims 1 and 7 and, thus, also would not have been rendered obvious by Segawa in view of Inoue. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

B. Claims 1, 4-8 and 10-12 Over Kurihara, Maisenhoelder, and Inoue

Claims 1, 4-8, and 10-12 are rejected under 35 U.S.C. §103(a) over Kurihara in view of Maisenhoelder and further in view of Inoue. Applicants respectfully traverse the rejection.

Independent claims 1 and 7 are set forth above. As with Segawa and Inoue, above, any combination of Kurihara and Maisenhoelder with Inoue also do not teach or suggest the claimed phase mask or method.

The Office Action asserts that Kurihara discloses a phase mask including a substrate having grooves formed with a groove pitch of between 0.85 and 1.25 μm. The Office Action concedes that Kurihara does not disclose varying a duty ratio of the grooves by varying widths and depths of the grooves according to their respective positions. However, the Office Action asserts that it would have been obvious to vary a duty ratio of the grooves by varying widths and depths of the grooves according to their respective positions in view of the teachings of Maisenhoelder. Further, the Office Action admits that Kurihara and Maisenhoelder do not teach that the plurality of grooves are arranged on the substrate in a single pitch, the duty ratios being determined by varied widths of the grooves. However, the Office Action argues that such a single constant pitch for the phase mask is taught by Inoue. Notwithstanding these assertions, Kurihara, Maisenhoelder, and Inoue do not teach or suggest the phase mask and method of claims 1 and 7.

As indicated above, in each of claims 1 and 7, a phase mask includes grooves arranged on a substrate in a single pitch, or a phase mask is prepared by forming grooves on a substrate in a single pitch. In claims 1 and 7, the widths of grooves vary depending on the position of the grooves. Furthermore, the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both peripheral portions of the substrate. Kurihara provides no disclosure regarding whether the grooves of the disclosed phase mask should have a constant or varying pitch, whether the grooves should have constant or varying widths depending on position or any other parameter, or that the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both peripheral portions of the substrate. Rather Kurihara merely discloses that grooves may be arranged with a pitch of between 0.85 and 1.25 μm. *See, e.g.,* paragraph [0017].

The Office Action correctly points out that Maisenhoelder discloses that a grating adjustment can be performed by changing the groove-to-land ratio and the grating depth of a phase mask. *See* paragraph [0172]. However, Maisenhoelder, like Kurihara, does not teach or suggest (a) that either the groove-to-land ratio or the grating depth can be changed <u>while maintaining a single pitch</u>, or (b) that the width of the grooves should <u>vary depending on the position</u> of the grooves. The only teaching or suggestion of forming grooves of a phase mask in such a manner is found in the instant specification. Of course, to rely on such teaching or suggestion would constitute impermissible hindsight. Nor does Maisenhoelder teach or suggest that the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both peripheral portions of the substrate, as claimed.

For at least these reasons, claims 1 and 7 would not have been rendered obvious by Kurihara and Maisenhoelder in view of Inoue. Claims 4-6, 8 and 10-12 depend variously from claims 1 and 7 and, thus, also would not have been rendered obvious by Kurihara and

Maisenhoelder in view of Inoue. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

IV. Double Patenting Rejections

Claims 7-8 and 10-12 are rejected for obviousness-type double patenting over claims 1, 4, and 7-9 of Segawa '614 in view of Segawa (cited above) and further in view of Inoue. Claims 7-8 and 10-12 are also rejected for obviousness-type double patenting over claims 1, 4, and 7-9 of Segawa '614 in view of Kurihara, Maisenhoelder, and Inoue. Applicants respectfully traverse the rejections.

The claims of Segawa '614 are cited for their disclosure of a method of producing an optical fiber-processing phase mask having a repeating pattern of grating shaped grooves and strips provided on one surface of a transparent substrate, so that diffracted light produced by the repeating pattern is applied to an optical fiber to fabricate a diffraction grating in the optical fiber by interference fringes of diffracted light of different orders, said method being characterized in that in making a mask having a plurality of juxtaposed patterns having a linearly or nonlinearly increasing or decreasing pitch and a uniform groove strip width ratio, multiple exposure is carried out to minimize difference between a pitch at a joint between patterns having different pitch data and a pitch in each individual pattern. See Segawa '614 claim 1. Segawa, Kurihara, Maisenhoelder, and Inoue are all cited as described above.

However, regardless of the teachings of the claims of Segawa '614, any combination of those claims with the other cited references would not have rendered obvious the claimed invention, for all of the reasons set forth above. In particular, neither the claims of Segawa '614 nor the cited references teach or suggest at least the instant claim limitation that the duty ratio is highest at a center position of the substrate, and decreases proportionally toward both peripheral portions of the substrate.

For at least these reasons, claims 7-8 and 10-12 would not have been rendered obvious by any combination of claims 1, 4, and 7-9 of Segawa '614 with Segawa and Inoue or Kurihara, Maisenhoelder, and Inoue. Reconsideration and withdrawal of the rejection are respectfully requested.

V. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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JAO:JSA

Attachments:
- Petition for Extension of Time
- Reference from www.ericweisstein.com/research
- Reference from www.wikipedia.org

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Apodization

From Wikipedia, the free encyclopedia

Apodization literally means "removing the foot". It is the technical term for changing the shape of a mathematical function, an electrical signal, an optical transmission or a mechanical structure to remove or smooth a discontinuity at the edges. An example of apodization is the use of the Hann window in the Fast Fourier transform analyzer to smooth the discontinuities at the beginning and end of the sampled time record.

In optical design jargon, an *apodization* function is used to purposely change the input intensity profile of an optical system, and may be a complicated function to tailor the system to certain properties. Usually it refers to a non-uniform illumation or transmission profile that approaches zero at the edges. The diaphragm of a photo camera is not strictly an example of apodization, since the stop doesn't produce a smooth transition to zero intensity, nor does it provide shaping of the intensity profile (beyond the obvious all-or-nothing, "top hat" transmission of its aperture). Simulation of a gaussian laser beam input profile is an example of apodization.

Apodization is used in telescope optics in order to improve the dynamic range of the image. For example, stars with low intensity in the close vicinity of very bright stars can be made visible using this technique. Generally, apodization reduces the resolution of an optical image; however, because it reduces diffraction edge effects, it can actually enhance certain small details.

See also

- Apodization function

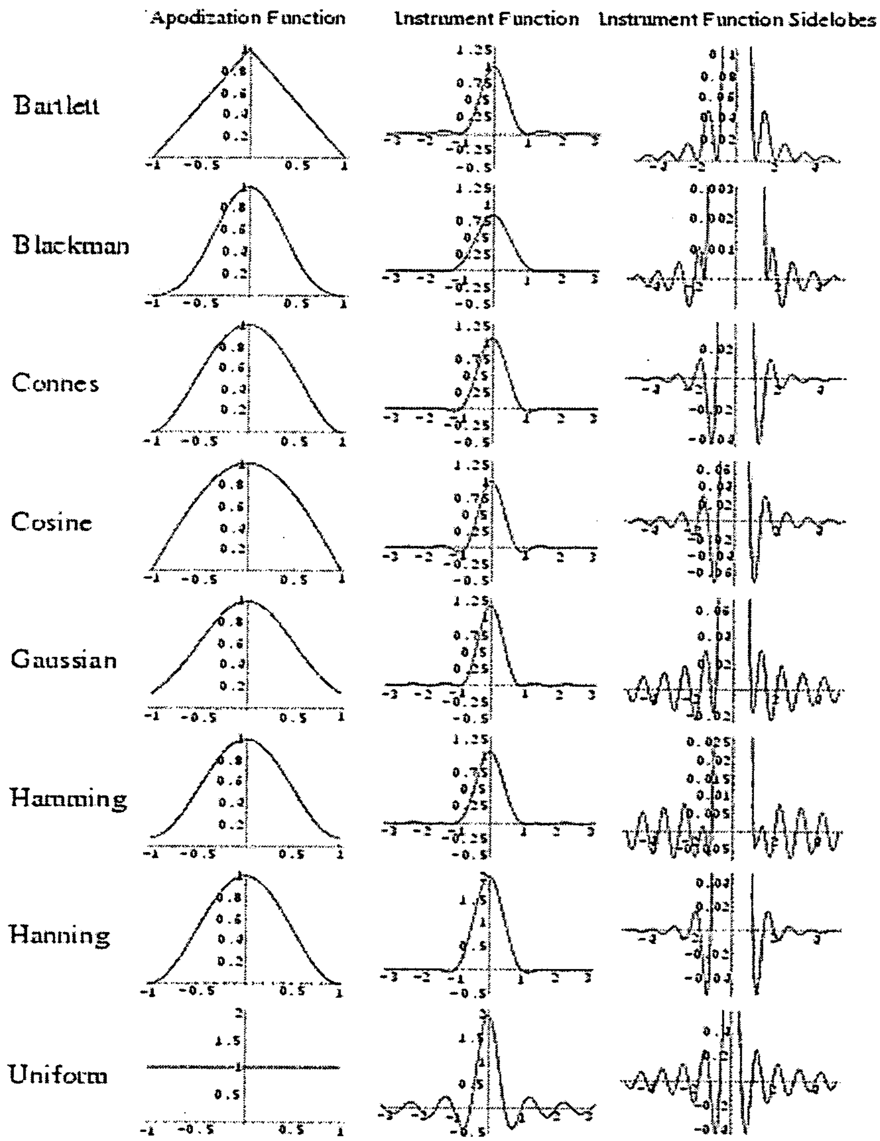
References

Apodization in Optics [1] (http://www.zemax.com/kb/articles/164/1/What-Does-the-Term-Apodization-Mean/Page1.html)

Apodization

Apodization, sometimes also called tapering, is a mathematical technique used to reduce the Gibbs phenomenon ``ringing" which is produced in a spectrum obtained from a truncated interferogram. Since interferograms can only be measured out to some finite distance, all laboratory interferograms are truncated. As shown by (), the observed spectrum is related to the true spectrum by a convolution with the ``instrument function" (or ``apparatus function") obtained by Fourier transforming the apodization function. The instrument function corresponding to the simplest apodization--the rectangle function produced by a finite-length interferogram--is a sinc function. Because of the large sidelobes of this function, it is sometimes desirable to multiply the original interferogram by some other function which goes smoothly to zero at the end of the interferogram (e.g., Schnopper and Thompson 1974). Table lists the most commonly used apodization functions and their transforms, both of which are plotted in Fig. .

Figure 4.4: Apodization functions, their instrument functions, and blowups of the first few sidelobes.



While apodization suppresses sidelobes, it also results in a broadening of spectral features (Thompson *et al.* 1991, p. 239). Table lists the widths, peak, and peak sidelobes of the apodization functions in Table . For a given application, these two factors must be balanced when selecting an appropriate apodization function. Spectra obtained with the CSO FTS have been processed using a variety of apodization functions. For planetary interferograms, apodization made no discernible difference. This is true because the broad width of planetary features smears out the ringing of the instrument functions, averaging out their effect. Furthermore, because the signal levels in our interferograms are very weak near the maximum optical path difference, the interferograms are effectively ``self-apodized'' by noise, making additional apodization unnecessary. Even for fairly narrow lines such as those in the Orion Molecular Cloud core (Serabyn and Weisstein 1995), only a single sidelobe of ringing was evident for the strongest CO lines. In this case, the desire for the highest possible resolution precluded the use of apodization.

Table 4.1: Various commonly used apodization functions and their corresponding instrument functions as illustrated in Fig. . L is the length of the one-sided portion of an interferogram (in sample numbers).

Type	Apodization Function	Instrument Function
Bartlett	$1 - \frac{\lvert x \rvert}{L}$	$L\,\mathrm{sinc}^2(\pi k L)$
Blackman		

	$0.42+0.5\cos\left(\frac{\pi x}{L}\right)+0.08\cos\left(\frac{2\pi x}{L}\right)$	$\frac{L(0.84-0.36L^2k^2-2.17\times10^{-19}L^4k^4)\,\mathrm{sinc}(2\pi Lk)}{(1-L^2k^2)(1-4L^2k^2)}$
Connes	$\left(1-\frac{x^2}{L^2}\right)^2$	$8L\sqrt{2\pi}\,\frac{J_{5/2}(2\pi kL)}{(2\pi kL)^{5/2}}$
Cosine	$\cos\left(\frac{\pi x}{2L}\right)$	$\frac{4L\cos(2\pi Lk)}{\pi(1-16L^2k^2)}$
Gaussian*	$e^{-x^2/(2\sigma^2)}$	$2\int_0^L \cos(2\pi kx)e^{-x^2/(2\sigma^2)}\,dx$
Hamming	$0.54+0.46\cos\left(\frac{\pi x}{L}\right)$	$\frac{L(1.08-0.64L^2k^2)\,\mathrm{sinc}(2\pi Lk)}{1-4L^2k^2}$
Hanning †	$\cos^2\left(\frac{\pi x}{2L}\right)$	$\frac{L\,\mathrm{sinc}\,(2\pi Lk)}{1-4L^2k^2}$
Uniform	1	$2L\,\mathrm{sinc}\,(2\pi kL)$

*For Gaussian apodization, σ^2 is the variance of the Gaussian function, which can be chosen independently of L. † The instrument function for Hanning apodization can also be written

$$a[\mathrm{sinc}(2\pi kL)+\tfrac{1}{2}\,\mathrm{sinc}(2\pi kL-\pi)+\tfrac{1}{2}\,\mathrm{sinc}(2\pi kL+\pi)].$$

Table 4.2: Width, peak value, and peak positive and negative sidelobes for the instrument functions illustrated in Fig. . The values for Gaussian apodization depend on the choice of the Gaussian variance σ^2.

Type	FWHM	PSF Peak	$\frac{\text{Peak } (-) \text{ Sidelobe}}{\text{Peak}}$	$\frac{\text{Peak } (+) \text{ Sidelobe}}{\text{Peak}}$
Bartlett	1.77179	1	0.00000000	0.0471904
Blackman	2.29880	0.84	-0.00106724	0.00124325
Connes	1.90416	$\frac{16}{15}$	−0.0411049	0.0128926
Cosine	1.63941	$\frac{4}{\pi}$	−0.0708048	0.0292720
Gaussian	--	1	--	--
Hamming	1.81522	1.08	-0.00689132	0.00734934
Hanning	2.00000	1	−0.0267076	0.00843441
Uniform	1.20671	2	−0.217234	0.128375
